

We Claim:

1. A process for forming a multilayer three-dimensional structure, comprising:
  - (a) forming and adhering a layer of material to a previously formed layer or to a substrate;
  - (b) repeating the forming and adhering operation of (a) a plurality of times to build up a three-dimensional structure from a plurality of adhered layers; wherein the formation of at least a plurality of layers, comprises:
    - (1) obtaining a selective pattern of deposition of a first material having voids, comprising at least one of:
      - (a) selectively depositing a first material onto a substrate or previously formed layer such that voids remain; or
      - (b) depositing a first material onto a substrate or previously formed layer and selectively etching the deposit of the first material to form voids therein; and
    - (2) depositing a second material into the voids via a thermal spraying process.
2. The process of claim 1 wherein the formation of the plurality of layers additionally comprises at least one planarization operation on each of at least a portion of the plurality of layers.
3. The process of claim 1 wherein the thermal spraying process comprises at least one of: (1) an arc wire spraying process, (2) a high velocity oxygen-fuel (HVOF) spraying process, (3) a plasma spraying process, (4) a plasma transferred arc (PTA) spraying process, (5) a vacuum or low pressure plasma spraying process, (6) a low velocity oxygen-fuel (LVOF) spraying process, (7) a detonation thermal spraying process, (8) a high velocity particle consolidation (HVPC) spraying process, (9) a wire spraying process, or (10) an ion plating process.
4. The process of claim 1 wherein after depositing via a thermal spraying process an infiltration process is used to fill any surface voids with a third material.

5. The process of claim 1 wherein after depositing via a thermal spraying process, at least one subsequent operation is used wherein modification of the second material occurs or wherein adhesion between the second material deposited in association with one layer and material deposited in association with another layer is enhanced.

6. A process for forming a multilayer three-dimensional structure, comprising:

- (a) forming and adhering a layer of material to a previously formed layer or to a substrate;
- (b) repeating the forming and adhering operation of (a) a plurality of times to build up a three-dimensional structure from a plurality of adhered layers; wherein the formation of at least a plurality of layers, comprises:
  - (1) obtaining a selective pattern of deposition of a first material having voids, comprising at least one of:
    - (a) selectively depositing a first material onto a substrate or previously formed layer such that voids remain; or
    - (b) depositing a first material onto a substrate or previously formed layer and selectively etching the deposit of the first material to form voids therein; and
  - (2) depositing a second material into the voids;
  - (3) etching the deposit of the first material or second material to form second voids; and
  - (4) depositing a third material into the second voids via a thermal spraying process.

7. The process of claim 6 wherein the formation of the plurality of layers additionally comprises at least two planarization operations on each of at least a portion of the plurality of layers.

8. The process of claim 6 wherein the formation of the plurality of layers additionally comprises at least one planarization operation on each of at least a portion of the plurality of layers.

9. The process of claim 6 wherein the thermal spraying process comprises at least one of: (1) an arc wire spraying process, (2) a high velocity oxygen-fuel (HVOF) spraying process, (3) a plasma spraying process, (4) a plasma transferred arc (PTA) spraying process, (5) a vacuum or low pressure plasma spraying process, (6) a low velocity oxygen-fuel (LVOF) spraying process, (7) a detonation thermal spraying process, (8) a high velocity particle consolidation (HVPC) spraying process, (9) a wire spraying process, or (10) an ion plating process.

10. The process of claim 6 wherein after depositing via a thermal spraying process an infiltration process is used to fill any surface voids with a fourth material.

11. The process of claim 6 wherein after depositing via a thermal spraying process, at least one subsequent operation is used wherein modification of the third material occurs or wherein adhesion between the third material deposited in association with one layer and material deposited in association with another layer is enhanced.

12. A process for forming a multilayer three-dimensional structure, comprising:

- (a) forming and adhering a layer of material to a previously formed layer or to a substrate;
- (b) repeating the forming and adhering operation of (a) a plurality of times to build up a three-dimensional structure from a plurality of adhered layers;
  - wherein the formation of at least a plurality of layers, comprises:
    - (1) obtaining a selective pattern of deposition of a first material having voids, comprising at least one of:
      - (a) selectively depositing a first material onto a substrate or previously formed layer such that voids remain; or
      - (b) depositing a first material onto a substrate or previously formed layer and selectively etching the deposit of the first material to form voids therein; and
    - (2) depositing a second material into the voids wherein the second material prior to deposition comprises a powder.

13. The process of claim 12 wherein the formation of the plurality of layers additionally comprises at least one planarization operation on each of at least a portion of the plurality of layers.

14. The process of claim 12 wherein the material comprising the powder, further comprises at least one of (1) at least two powders of different materials, (2) at least two powders with different particle size distributions, (3) a liquid carrier for the powder, (4) a transformable binder that can be used to bind the powder particles, or (5) a liquid carrier that can be transformed by radiation, heat, pressure, or chemical means to bind the powder particles.

15. The process of claim 12 wherein after depositing the powder an infiltration process is used to fill any surface voids with a third material.

16. The process of claim 12 wherein after depositing the powder, at least one subsequent operation is used wherein modification of the second material occurs or wherein adhesion between the second material deposited in association with one layer and material deposited in association with another layer is enhanced.

17. A process for forming a multilayer three-dimensional structure, comprising:

- (a) forming and adhering a layer of material to a previously formed layer or to a substrate;
- (b) repeating the forming and adhering operation of (a) a plurality of times to build up a three-dimensional structure from a plurality of adhered layers; wherein the formation of at least a plurality of layers, comprise:
  - (1) obtaining a selective pattern of deposition of a first material having voids, comprising at least one of:
    - (a) selectively depositing a first material onto a substrate or previously formed layer such that voids remain; or
    - (b) depositing a first material onto a substrate or previously formed layer and selectively etching the deposit of the first material to form voids therein; and
  - (2) depositing a second material into the voids;

- (3) etching the deposit of the first material or second material to form second voids; and
- (4) depositing a third material into the second voids, wherein the third material prior to deposition comprises a powder.

18. The process of claim 17 wherein the formation of the plurality of layers additionally comprises at least two planarization operations on each of at least a portion of the plurality of layers.

19. The process of claim 17 wherein the formation of the plurality of layers additionally comprises at least one planarization operation on each of at least a portion of the plurality of layers.

20. The process of claim 17 wherein the material comprising the powder, further comprises at least one of (1) at least two powders of different materials, (2) at least two powders with different particle size distributions, (3) a liquid carrier for the powder, (4) a transformable binder that can be used to bind the powder particles, or (5) a liquid carrier that can be transformed by radiation, heat, pressure, or chemical means to bind the powder particles.

21. The process of claim 17 wherein after depositing the powder an infiltration process is used to fill any surface voids with a third material.

22. The process of claim 17 wherein after depositing the powder, at least one subsequent operation is used wherein modification of the second material occurs or wherein adhesion between the second material deposited in association with one layer and material deposited in association with another